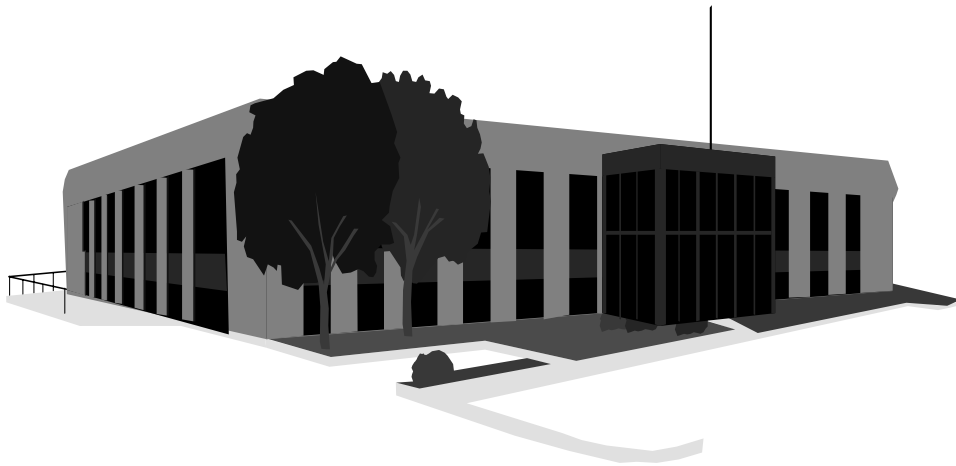


INDOOR AIR QUALITY ASSESSMENT

**Clement G. McDonough Arts Magnet School
40 Paige Street
Lowell, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
January, 2001

Background/Introduction

At the request of the Lowell Health Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) was asked to provide assistance and consultation regarding indoor air quality issues and health concerns at the McDonough Arts Magnet School in Lowell, Massachusetts. Reports of respiratory irritation and exacerbation of allergies prompted this assessment.

On November 16, 2000 Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program, BEHA conducted an indoor air quality assessment. John Collins of the Lowell Health Department and John Wolfgang, Head Custodian, accompanied Mr. Holmes for portions of the assessment. BEHA staff returned on November 21 to conduct carbon monoxide testing in areas of the school adjacent to the boiler plant. These areas were believed to be impacted by exhaust emissions.

The McDonough Magnet complex is a three-story brick building that contains both the “Arts” and “City” schools, which are connected by a common hallway. The building was originally constructed in the late 1800’s and served as a trade school. In the 1930’s an addition was built that currently houses the “City” school. Between 1985-1987 the McDonough complex was renovated and a theatre was added to the “Arts” building. The boiler plant serving both schools is located in a building adjacent to the complex. Each school is equipped with a mechanical ventilation system, which functions independently from the other school. For this reason, the conditions in each building will be described in separate reports. The focus of this report is the space occupied by the “Arts” Magnet School. The “City” Magnet School will be the subject of a separate report.

The section occupied by the school consists of general classrooms, art rooms, photo studio, library, computer room and office space. The Arts and City schools share a common theatre and gymnasium; the gymnasium also functions as the kitchen/cafeteria. Windows in the school are openable.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Moisture content in the interior lining of the rooftop air handling unit (AHU) was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The school houses grades K-8 with a student population of approximately 335 and a staff of approximately 45. The tests were taken under normal operating conditions. Test results appear in Tables 1-8.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in twenty-nine of thirty-three areas surveyed, indicating an overall ventilation problem in the school. It is also important to note that a large number of classrooms had open windows during the assessment, which can greatly contribute to reduced carbon dioxide levels.

Ventilation is provided by a single AHU located on the roof of the “City” school (see Picture 1). Fresh air is distributed via ductwork connected to wall-mounted air diffusers in classrooms (see Picture 2). The amount of fresh air drawn into the units is controlled by moveable louvers connected to an activator motor that adjusts to alter fresh air intake to maintain temperature. The day of the assessment the AHU was shut down therefore no fresh air was being mechanically provided.

Exhaust ventilation is provided by wall-mounted grates (see Picture 2) that return air back to the AHUs via ductwork. It was reported by school officials that the AHU was deactivated over the summer of 2000 due to damage to the interior fiberglass lining of the AHU and ductwork, and that it has not been activated this school year. Without dilution and removal by the mechanical ventilation system, normally occurring environmental pollutants can build up and lead to indoor air quality and comfort complaints. BEHA staff examined the AHU and found both the exterior and interior insulation severely damaged (see Pictures 3-6).

Further complicating the distribution of air in the building is the addition of the theatre to the rear of the “Arts” school. School officials reported that the theatre was constructed without any modification to the existing HVAC system. The Arts school theatre does not have its own system, furthermore it is located at the furthest point from the rooftop AHU (see Figure 1), limiting the amount of fresh air provided to this area. It is common practice for large common areas such as cafeterias, gymnasiums, and/or auditoriums/theaters to have a separate HVAC system from a school’s general HVAC system since the ventilation requirements/usage are different than general classrooms.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be

balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was performed in February of 1989 (Certified Engineering, 1989).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 66° F to 78° F, which were outside the BEHA recommended range in some areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Temperature control complaints were expressed to BEHA staff in a number of areas, including the theatre. It is difficult to control temperature and maintain comfort without the air handling equipment operating as designed. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Heat complaints were reported in the computer room, which contained 30 (+) computers and a number of printers. The computer room has a relatively small floor space, with few windows and no air conditioning. Computer equipment and printers can generate waste heat while they operate, which can build up over time in an area without adequate ventilation. Lack of ventilation can lead to poor air quality and comfort complaints.

The relative humidity in the building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 23 to 37 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

BEHA staff examined the interiors of the AHU and accessible ventilation ductwork. The AHU and its ductwork are lined with fiberglass insulation. The interior of the AHU was inspected and was found saturated with evidence of possible microbial

growth (see Picture 7). Rooftop ductwork had visible water damage to the top, sides and bottom of the interior lining of ductwork insulation (see Pictures 8 & 9). Moisture measurements were taken in the AHU and duct insulation where accessible. These measurements and observed damage indicate that the watertight integrity of the ductwork has been breached. Moisture readings in insulation ranged from 8.2 percent to a peak of 99.9 percent.

Picture 10 shows the condition of the bottom of ductwork, which appears to have “bowed” due to the increased weight of the saturated ductwork liner/insulation. Below this area was a pile of wet fiberglass material, which appears to have come from the inside of the unit (see Picture 11) further indicating that the integrity of the ductwork has been compromised. Fiberglass is a porous material, which provides a medium for mold and mildew growth when it becomes repeatedly moistened. Mold growth inside an air-handler/duct work can be distributed to occupied areas via the ventilation system, if activated.

Standing water was noted in a number of areas on the roof, including under air handling equipment (see Picture 1). During operation of the AHUs, there is a potential for the entrainment of moisture into the HVAC system, which can lead to mold growth within the unit, and then in turn distributed to occupied areas via ductwork if activated. The collection of water and its subsequent freezing and thawing during winter months can lead to roof leaks resulting in water penetration into the interior of the building. Pooling water can also become stagnant, which can lead to mold and bacterial growth, resulting in unpleasant odors and providing a breeding ground for mosquitoes.

Water damaged ceiling tiles were observed in a number of areas. Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered.

A few areas had plants. Plant soil and drip pans can serve as source of mold growth. Plants should be properly maintained and be equipped with drip pans. Plants should also be located away from the air stream of mechanical ventilation to prevent aerosolization of dirt, pollen or mold.

In a number of classrooms, spaces between the sink countertop and backsplash were noted. A leaking faucet was noted in the health suite. Repeated leakage or improper drainage/overflow can lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly it can provide a medium for mold growth.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. The main office and teachers' lounges have photocopiers. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). School personnel should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in these areas.

Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

As previously noted, the AHU was not operating. The AHU is equipped with filters that strain particulates from airflow. The filters provide filtration of respirable

dusts. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop) which can reduce the efficiency of the AHUs due to increased resistance. Prior to any increase of filtration, the AHU should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

The building was reported to have a history of rodent infestation. Bait traps were noted in cabinets beneath sinks in several areas. Under current Massachusetts law that will go into effect November 1, 2001, the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). A copy of the IPM guide is attached as [Appendix A](#).

School officials reported a reoccurring problem with exhaust entrainment from the boiler plant located adjacent to the school. Although no odors of exhaust emissions or measurable levels of carbon monoxide were noted indoors by BEHA staff during both site visits, the possibility of entrainment exists. The boilers release emissions from a series of vent pipes approximately 10-15' below the plant roof (see Picture 12). Certain wind and weather conditions can direct boiler exhaust emissions toward and into the open windows or air intakes of the adjacent school building (see Picture 13). Boiler exhaust and wind conditions should be closely monitored to avoid the entrainment of emissions inside the building via open doors, windows and/or AHU fresh air intakes.

Severe water damage to the fiberglass insulation lining the ductwork may also be a source of microbial exposures. Man made building materials can break down over time or can become mechanically damaged. Under certain conditions, the insulation constituents could become airborne and be distributed to occupied areas via the ventilation system. Fiberglass can also serve as an eye, skin and respiratory irritant.

Classroom 303 had a 1-gallon container of paint thinner in the cabinet under the sink; classrooms 201 & 203 contained spray cans of graffiti remover. The art room had a 1-gallon container of paint thinner stored on top of a flammables cabinet. Strong chemical odors were noted upon opening the flammable cabinet. BEHA staff observed a thick, dark substance spilled on the bottom of the cabinet (see Picture 14), which appeared to be the most likely source of odors. Paint thinners, certain art supplies and other flammable materials contain VOCs which can cause eye, throat and respiratory irritation. In addition, flammable materials found in classrooms should be stored in a storage cabinet that meets design criteria set forth by the National Fire Protection Association (NFPA, 1996).

Conclusions/Recommendations

The solution to the indoor air quality problem at the Arts Magnet School is complex. The combination of the general conditions, configuration of the ventilation system, the modification of space, and the condition of HVAC equipment, if considered individually, would present conditions that can serve to degrade indoor air quality. When combined, these conditions can serve to further affect indoor air quality in the building. Some of these conditions can be remedied by actions of building occupants. Other

remediation efforts will require alteration to the building structure and equipment. For these reasons a two-phase approach is required, consisting of more immediate (**short-term**) measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns. In view of the findings at the time of this visit, the following recommendations are made:

The following **short-term** measures should be considered for immediate implementation:

- 1) Hire an HVAC engineering firm to evaluate the ventilation system. **Do not activate HVAC system until damaged ductwork and interior lining of the AHU is repaired/replaced.**
- 2) If fiberglass liner of AHU and/or ductwork is replaced the interior of the AHU should be vacuumed out, cleaned with an appropriate antimicrobial, and allowed to completely dry before operation.
- 3) Once operating, both supply and exhaust ventilation should operate continuously during periods of school occupancy.
- 4) Repair and/or replace thermostats as necessary to maintain control of thermal comfort.
- 5) Consider increasing the dust-spot efficiency of HVAC filters. Note that increased filtration can reduce airflow produced through increased resistance. Prior to any increase of filtration, the AHU should be evaluated by a ventilation engineer to determine whether they can maintain function with more efficient filters.
- 6) For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high

- efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
- 7) Ensure plants have drip pans. Examine drip pans for mold growth and disinfect areas with an appropriate antimicrobial where necessary.
 - 8) Ensure exhaust ventilation is operating during photocopying to help remove excess heat and odors.
 - 9) Clean chalkboards and trays regularly to prevent the build-up of excessive chalk dust.
 - 10) Fix leaking faucet in the health suite. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect wallboard for water-damage and mold/mildew growth, repair/replace as necessary. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.
 - 11) Acquire current Material Safety Data Sheets for all products that contain hazardous materials and are used within the building, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL. 1983).
 - 12) Determine the identification of spilled substance in the flammable storage cabinet of art room 300 and obtain MSDS. Clean up spill in accordance with the MSDS sheet using appropriate health and safety precautions.
 - 13) Store flammable materials in flameproof cabinets consistent with local and state fire codes.
 - 14) It is highly recommended that the principles of integrated pest management (IPM) be used to rid this building of pests. As previously noted, a copy of the

Massachusetts IPM recommendations is included with this report as Appendix A (MDFA, 1996). Activities that can be used to eliminate pest infestation may include the following:

- a) Rinse out recycled food containers. Seal recycled containers with a tight fitting lid to prevent insect access.
 - b) Remove non-food items (e.g. materials containing cellulose) that insects may be consuming.
 - c) Store foods in tight fitting containers.
 - d) Avoid eating in classrooms. In areas where food is consumed, periodic vacuuming to remove crumbs is recommended.
 - e) Regularly clean crumbs and other food residues from toasters, toaster ovens, microwave ovens, coffeepots and other food preparation equipment.
 - f) Examine each room and the exterior walls of the building for means of egress and seal. If doors do not seal at the bottom, install a weather strip as a barrier to pests.
 - g) Reduce harborages (cardboard boxes) where insects may reside.
- 15) Close classroom windows and doors adjacent to the boiler plant during wind/weather conditions conducive for the entrainment of exhaust odors. Consider extension of the boiler exhaust vent pipes if problem persists.

The following **long-term measures** should be considered:

1. As previously discussed, the age, physical deterioration and availability of parts for the mechanical ventilation system should be fully evaluated by an HVAC engineering firm to determine the operational lifespan of existing equipment and/or examining the feasibility of replacement. As previously mentioned, during

this evaluation it is strongly advised to determine the integrity of fiberglass lined ductwork.

2. Have an HVAC engineer determine the proper provision of airflow in the theatre. Consider installing a separate AHU to provide fresh air solely to the theatre.
3. Consider providing air conditioning to the computer room to help reduce excess heat generated by computers and related equipment.
4. Continue to isolate and repair water leaks. Repair/replace any water-damaged ceiling tiles, wallboard and/or other damaged building materials. Examine above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial. Building occupants should report any roof leaks or other signs of water penetration to school maintenance staff for prompt remediation.
5. Inspect roof for proper drainage; consider consulting a building engineer about possible options to eliminate water pooling on roof.
6. Repair/replace loose/broken windowpanes and missing or damaged window caulking building-wide to prevent water penetration through window frames.

Because a number of the recommendations may require remediation efforts that will require alteration to the building structure and equipment; the following recommendations in addition to the steps previously noted, should be implemented in order to reduce the migration of renovation generated pollutants into occupied areas. We suggest that these steps be taken on any renovation project within a public building:

1. Establish communications between all parties involved with building renovations to prevent potential IAQ problems. Develop a forum for occupants to express concerns about renovations as well as a program to resolve IAQ issues.
2. Develop a notification system for building occupants immediately adjacent to construction activities to report construction/renovation-related odors and/or dust(s) problems to the building administrator. Have these concerns relayed to the contractor in a manner to allow for a timely remediation of the problem.
3. When possible, schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.
4. Disseminate scheduling itinerary to all affected parties. This can be done in the form of meetings, newsletters or weekly bulletins.
5. Use local exhaust ventilation and isolation techniques to control for renovation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the school's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).
6. Obtain Material Safety Data Sheets (MSDS) for all construction materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).

7. Consult MSDS' for any material applied to the effected area during renovation(s) including any sealant, carpet adhesive, tile mastic, flooring and/or roofing materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.
8. Seal utility holes, spaces in floor decking and temporary walls to eliminate pollutant paths of migration. Seal holes created by missing tiles in ceiling temporarily to prevent renovation pollutant migration.
9. If possible, relocate susceptible persons and those with pre-existing medical conditions (e.g., hypersensitivity, asthma) away from areas of renovations.
10. Implement prudent housekeeping and work site practices to minimize exposure to renovation pollutants. This may include constructing barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended.
11. Consider changing filters for HVAC equipment more regularly in areas impacted by renovation activities. Examine the feasibility of acquiring more efficient filters for these units.

References

ASHRAE. 1992. Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 52.1-1992.

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

Certified Engineering. 1989. Testing & Balancing Report for Arts & City Schools, Lowell, MA. February 2, 1989. Certified Engineering & Testing Company, Inc. Boston, MA.

Mass. Act. 2000. An Act Protecting Children and families from Harmful Pesticides. 2000 Mass Acts c. 85 sec. 6E.

MEHRC. 1997. Indoor Air Quality for HVAC Operators & Contractors Workbook. Mid Atlantic Environmental Hygiene Resource Center, Philadelphia, PA.

MGL. 1983. Hazardous Substances Disclosure by Employers. Massachusetts General Laws. M.G.L. c. 111F.

NFPA. 1996. Flammable and Combustible Liquids Code. NFPA 30. . 1996 ed. National Fire Prevention Association, Quincy, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

SMACNA. 1995. IAQ Guidelines for Occupied Buildings Under Construction. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc, Chantilly, VA.

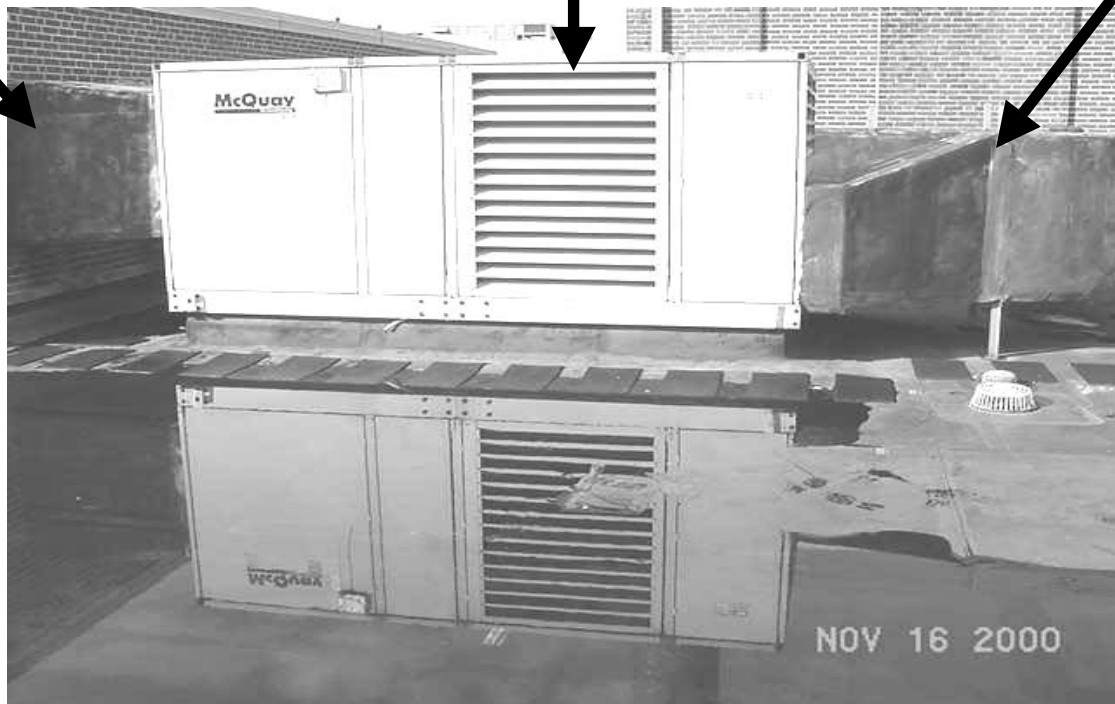
Thornburg, D. Filter Selection: a Standard Solution. *Engineering Systems* 17:6 pp. 74-80.

Picture 1

Supply ductwork

Air intake

Return ductwork



**AHU for “Arts” Magnet School Stationed on the Rooftop of the “City” Magnet School
Note Pooling Water below Fresh Air Intake**

Picture 2

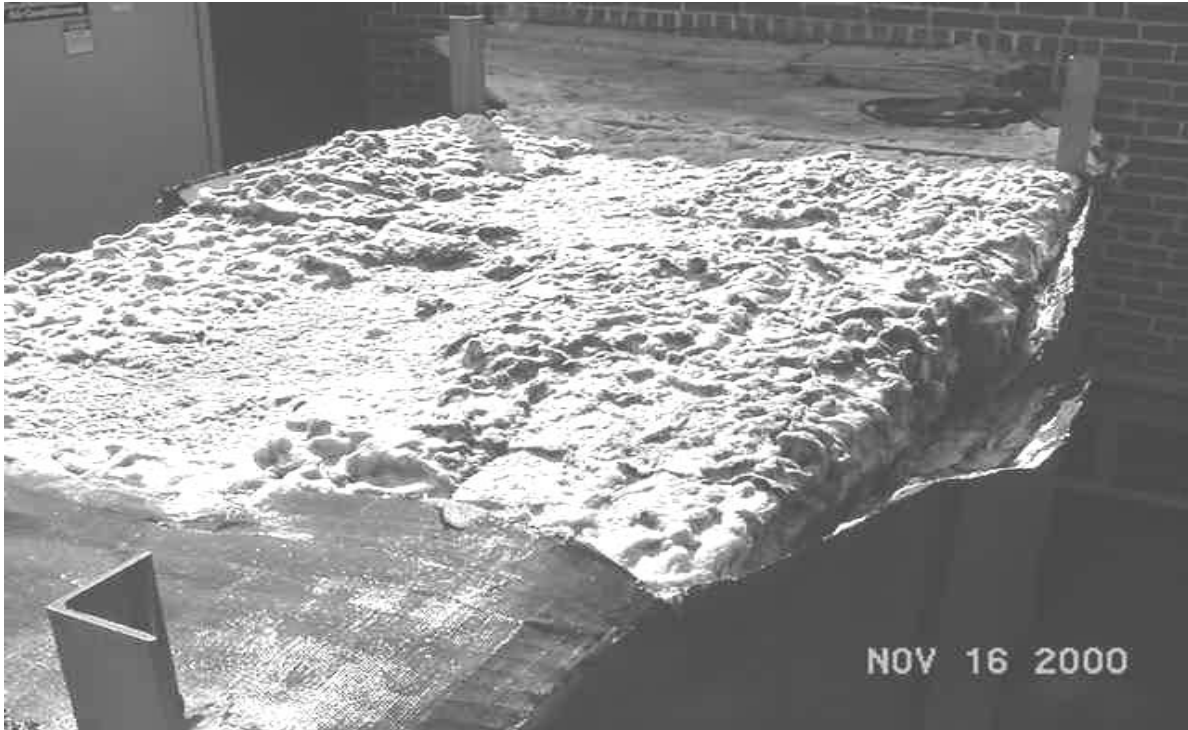
Supply diffuser

Return diffuser



Example of Typical Supply and Return Air Diffusers

Picture 3



Damaged Exterior Ductwork Insulation Note Liner is Splayed Exposing Insulation Material

Picture 4



Plant Growth Protruding from Damaged Ductwork Insulation

Picture 5



Damaged Insulation Observed in Interior of Ductwork

Picture 6



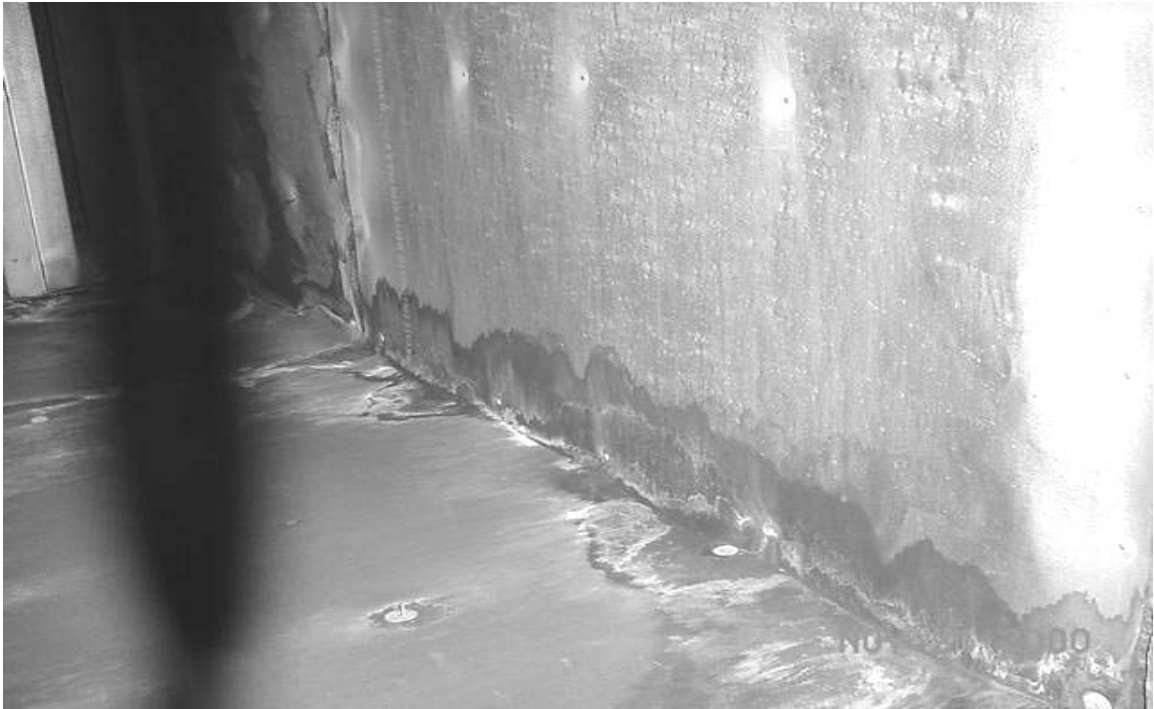
Damaged Insulation Observed in Interior of Ductwork

Picture 7



**Water Damaged Interior Lining of Ductwork Insulation
Moisture Content Readings in This Area Measured 99.9 % indicating Saturation**

Picture 8



Water Stains along Bottom/Side of Interior Ductwork Insulation

Picture 9



Water Stains along Top/Side of Interior Ductwork Insulation

Picture 10



Underside of Ductwork Note Torn Water Damaged Liner

Picture 11



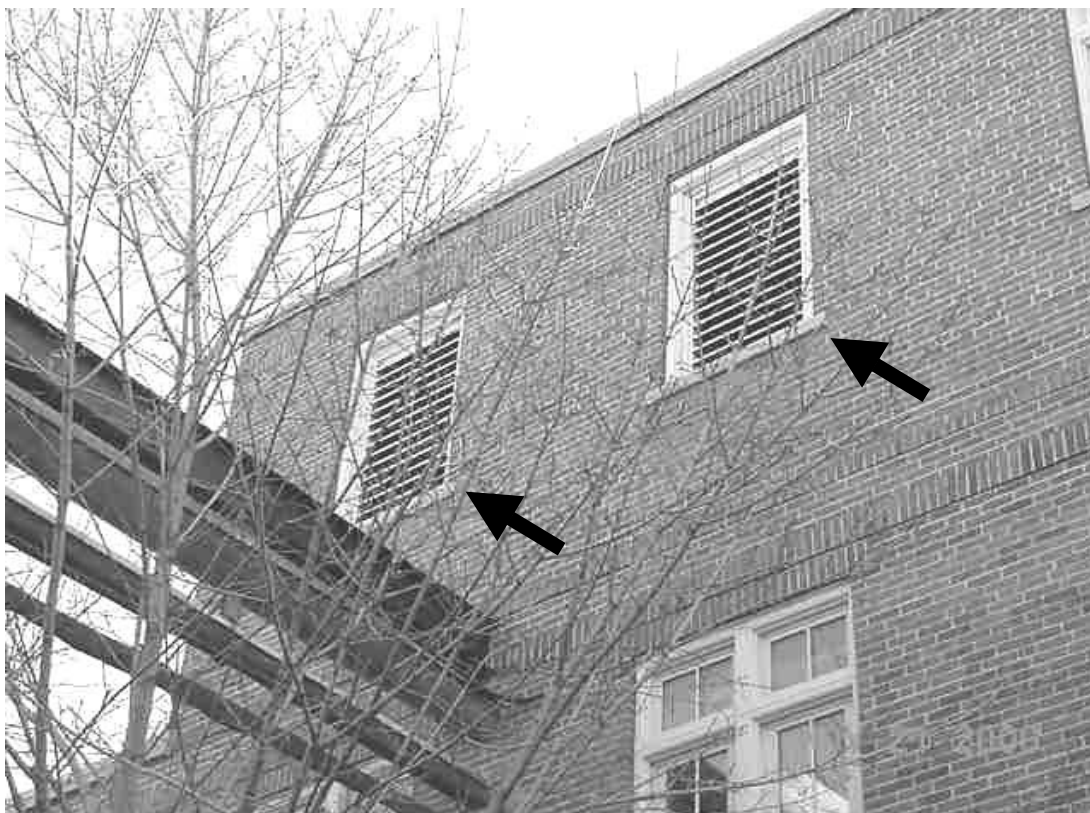
Accumulated Insulation Material Outside Ductwork

Picture 12



Boiler Plant Vent Pipes

Picture 13



Air Intakes for AHU Adjacent to Boiler Plant

Picture 14



Interior of Art Room (300) Flammable Cabinet Note Dark Material Spilled at Bottom of Cabinet

TABLE 1

Indoor Air Test Results –Magnet “Arts” School, Lowell, MA – November 16, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|-------------------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|--|
| | | | | | | Intake | Exhaust | |
| Outside (Background) | 418 | 51 | 39 | | | | | Weather conditions: cool, cloudy |
| 4 th Floor Hallway | | | | | | | | 4 CT, skylight |
| Roof Notes | | | | | | | | AHU located on roof of “City” Magnet bldg.-shut down for liner replacement, exterior liner of return duct breached-exposed fiberglass, moss/vegetation growth, large pools of water |
| 300 Arts | 826 | 66 | 37 | 1 | Yes | Yes | Yes | Window and door open, 16 occupants gone <5 min., lamination machine, kiln-vented, flammables cabinet-flammable on top of cabinet-odors upon opening-leaking materials-some covers not secure |
| 302 Choral Room | 940 | 73 | 30 | 0 | Yes | Yes | Yes | Window open, 3 plants, dark stains on ceiling tiles near vent, chalk dust |
| Teacher’s Room | 655 | 73 | 27 | 1 | Yes | Yes | Yes | Window open, bait trap (mice) under sink, recyclables in box, |

Comfort Guidelines

* ppm = parts per million parts of air
 CT = ceiling tiles
 CO = carbon monoxide

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results –Magnet “Arts” School, Lowell, MA – November 16, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|---|
| | | | | | | Intake | Exhaust | |
| | | | | | | | | refrigerator-drip pan |
| Practice Room C | 1263 | 73 | 31 | 4 | Yes | Yes | Yes | Door open |
| Practice Room B | 1500 | 73 | 32 | 3 | No | Yes | Yes | Dry erase board, door open |
| Practice Room A | 1200 | 72 | 31 | 0 | No | Yes | Yes | |
| 303 | 1478 | 73 | 30 | 28 | Yes | Yes | Yes | Window and door open, paint thinner under sink |
| 305 | 969 | 72 | 28 | 26 | Yes | Yes | Yes | Window and door open, spaces between sink countertop/backsplash |
| 304 | 1300 | 73 | 32 | 21 | Yes | Yes | Yes | Window open, chalk dust |
| 306 | 1324 | 74 | 32 | 26 | Yes | Yes | Yes | Window open |
| 307 | 1016 | 74 | 27 | 29 | Yes | Yes | Yes | Window open |
| 308 Photo Studio | 896 | 72 | 30 | 0 | No | Yes | Yes | Ceiling leaks around access panels, door open |

Comfort Guidelines

* ppm = parts per million parts of air
 CT = ceiling tiles
 CO = carbon monoxide

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results –Magnet “Arts” School, Lowell, MA – November 16, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|--|
| | | | | | | Intake | Exhaust | |
| 310 | 857 | 72 | 29 | 0 | Yes | Yes | Yes | Door open |
| 2 nd Floor Hallway Classroom | 935 | 74 | 30 | 6 | Yes | Yes | Yes | 3 CT |
| 210 | 1018 | 74 | 30 | 4 | Yes | Yes | Yes | Door open |
| 208 | 1600 | 76 | 33 | 23 | Yes | Yes | Yes | Window open, spaces around sink, 5 CT |
| 207 | 984 | 74 | 27 | 25 | Yes | Yes | Yes | Window open, spaces around sink, uncapped vinegar (1 gal.) under sink, cleaning product on countertop |
| 205 | 1608 | 75 | 32 | 23 | Yes | Yes | Yes | Occupant reports room is “filthy”, unlabeled spray product on countertop, water damaged splashboard around sink, dry erase board |
| 206 | 1005 | 76 | 27 | 14 | Yes | Yes | Yes | Window and door open, spaces around countertop |
| 204 | 1156 | 75 | 29 | 23 | Yes | Yes | Yes | Window open, spaces around sink countertop/splashboard, 5 CT |

Comfort Guidelines

* ppm = parts per million parts of air
 CT = ceiling tiles
 CO = carbon monoxide

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 4

Indoor Air Test Results –Magnet “Arts” School, Lowell, MA – November 16, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|--|
| | | | | | | Intake | Exhaust | |
| Reading Room | 1060 | 74 | 29 | 0 | Yes | Yes | Yes | |
| 203 | 1073 | 75 | 29 | 27 | Yes | Yes | Yes | Window and door open, spray cleaner on countertop, spaces around sink, flammables/graffiti remover under sink |
| Resource Room | 820 | 76 | 27 | 0 | Yes | Yes | Yes | 4 CT, 3 plants |
| 201 | 1074 | 76 | 27 | 18 | Yes | Yes | Yes | Spray cleaner on counter, spaces around countertop/splashboard, cleaning product/vandal remover under sink |
| 202 | 1004 | 78 | 26 | 19 | Yes | Yes | Yes | Plant, cleaning product under sink, spaces around sink |
| Library | 472 | 76 | 23 | 1 | Yes | Yes | Yes | Window open, 11+ plants, temperature complaints-heat, supply and exhaust vents in close proximity--~8ft./same wall |
| Computer Room | | | | | | Yes | Yes | 32 computers, small room/no a/c, temperature complaints-heat |

Comfort Guidelines

* ppm = parts per million parts of air
 CT = ceiling tiles
 CO = carbon monoxide

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 5

Indoor Air Test Results –Magnet “Arts” School, Lowell, MA – November 16, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|-----------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|---|
| | | | | | | Intake | Exhaust | |
| Main Office | 720 | 74 | 25 | 4 | Yes | Yes | Yes | 3 photocopiers |
| Health Suite | 893 | 74 | 26 | 3 | No | Yes | Yes | Door open, spaces around sink, active leak under sink |
| 100 – Industrial Arts | 420 | 67 | 25 | 1 | Yes | Yes | Yes | Window open, wood dust collection system |
| Cafeteria | 806 | 68 | 31 | ~350 | Yes | Yes | Yes | Window open |
| Kitchen | 864 | 71 | 34 | ~14 | Yes | Yes | | 1 small supply vent, temperature complaints (heat) |
| Theater | 430 | 70 | 26 | ~20 | Yes | Yes | Yes | Window open, ceiling fans, temperature complaints (heat), stuffiness, water stained ceiling-SW corner (over window) of auditorium, carpet |
| Kitchen | 1039 | 72 | 33 | 3 | No | Yes | No | No fans, no exhaust vent, food warmers, temperature complaints (heat) |

Comfort Guidelines

* ppm = parts per million parts of air
 CT = ceiling tiles
 CO = carbon monoxide

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 6

Indoor Air Test Results – Magnet “Arts” School, Lowell, MA – November 21, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|------------------------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|--|
| | | | | | | Intake | Exhaust | |
| Outside (Background) | 352 | 50 | 24 | | | | | CO=0 |
| AHU notes- 11/21/00 | | | | | | | | Odors, moisture readings taken: 1' inside duct=99.9% 5' inside duct=42% 5' inside side wall=8.2% 10' inside duct=20.3% exhaust vent 7' below intake |
| Library | | | | | | | | Carbon Monoxide (CO) = 0 ppm |
| Art Room 300 | | | | | | | | CO=0 |
| Office | | | | | | | | CO=0 |
| New Hallway | | | | | | | | CO=0 |
| Woodshop | | | | | | | | CO=0 |
| Basement Hallway- near elevator | | | | | | | | CO=0 |

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%